NASA Strategic Roadmaps

Briefing to the
Exploration of the Moon
Strategic Roadmap Committee

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Marc S. Allen
Advanced Planning and Integration Office

Topics

- What are NASA strategic roadmaps, and how do they relate to the Agency's goals?
- Why is NASA doing strategic roadmaps and how will we use them?
- What should they contain?
- An example of the concept
- What is the schedule?

Strategic Roadmap Definition

- **Strategic Roadmap:** A coordinated and comprehensive longitudinal strategy, with key achievements, options, and decision points identified, that provides a foundation for NASA's long-term priorities and investments
- There will be a roadmap for each Agency-level Objective
  - 13 roadmaps respond to 18 objectives
  - Consistent contents and structure to simplify integration
- NASA is also developing a set of 15 "Capability Roadmaps"
  - Based on Aldridge Commission recommendations
  - Iterate to ensure consistency with Strategic Roadmaps as they develop

NASA Strategic Goals and Objectives (1 of 2)

Goal 1 **Implement a sustained and affordable human and robotic program to explore the solar system and beyond**

1. **Undertake robotic and human lunar exploration . . .**
2. Conduct robotic exploration of Mars . . .
3. Conduct robotic exploration across the solar system . . .
4. Conduct advanced telescope searches for Earth-like planets . . .
5. Explore the Universe . . .

Goal 2 **Extend human presence across the solar system, starting with a human return to the Moon by the year 2020, in preparation for human exploration of Mars and other destinations**

1. Return the Space Shuttle to flight and focus its use on completion of the ISS, complete assembly of the ISS, and . . .
2. Develop a new crew exploration vehicle . . .
3. Focus research and use of the ISS . . .
4. **Conduct the first extended human expedition to the lunar surface . . .**
5. Conduct human expeditions to Mars . . .

NASA Strategic Goals and Objectives (2 of 2)

Goal 3 **Develop innovative technologies, knowledge, and infrastructure both to explore and to support decisions about the destinations for human exploration**

1. Develop and demonstrate . . . key capabilities . . .
2. Provide advanced aeronautical technologies . . .
3. Use NASA missions and other activities to inspire and motivate . . .

Goal 4 **Promote international and commercial participation in exploration to further U.S. scientific, security, and economic interests**

1. Pursue opportunities for international participation . . .
2. Pursue commercial opportunities . . .
3. Use NASA missions and other activities to inspire and motivate . . .

Goal 5 **Study the Earth system from space and develop new space-based and related capabilities for this purpose**

1. Conduct a program of research and technology development to advance Earth observation . . .
2. Explore the Earth-Sun system . . .

Strategic Roadmaps (1 of 2)

1. **Undertake robotic and human exploration of the Moon to further science, and to develop and test new approaches, technologies, and systems to enable and support sustained human and robotic exploration of Mars and more distant destinations. First robotic mission no later than 2008. (Goal 1, Objective 1)**

   Conduct the first extended human expedition to the lunar surface as early as 2015, but no later than the year 2020. (2-4)

2. Conduct robotic exploration of Mars to search for evidence of life, to understand the history of the solar system, and to prepare for future human exploration. (1-2)

   Conduct human expeditions to Mars after acquiring adequate knowledge about the planet using robotic missions, and after successfully demonstrating sustained human exploration missions to the Moon. (2-5)

3. Conduct robotic exploration across the solar system for scientific purposes and to support human exploration. In particular, explore Jupiter's moons, asteroids, and other bodies to search for evidence of life, to understand the history of the solar system, and to search for resources. (1-3)

4. Conduct advanced telescope searches for Earth-like planets and habitable environments around other stars. (1-4)

5. Develop a new crew exploration vehicle to provide crew transportation for missions beyond low Earth orbit. First test flight to be by the end of this decade with operational capability for human exploration no later than 2014. (2-2)

6. Focus research and use of the International Space Station on supporting space exploration goals, with emphasis on understanding how the space environment affects human health and capabilities, and developing countermeasures. (2-3)

Strategic Roadmaps (2 of 2)

7. Return the Space Shuttle to flight and focus its use on completion of the International Space Station (ISS), complete assembly of the ISS, and retire the Shuttle as soon as assembly of the ISS is completed, planned for the end of this decade. Conduct ISS activities consistent with U.S. obligations to Station partners. (2-1)
8. Explore the Universe to understand its origin, structure, evolution, and destiny. (1-5)
9. Conduct a program of research and technology development to advance Earth observation from space, improve scientific understanding, and demonstrate new technologies with the potential to improve future operational systems. (5-1)
10. Explore the Sun-Earth system to understand the Sun and its effects on Earth, the solar system, and the space environmental conditions that will be experienced by human explorers, and demonstrate technologies that can improve future operational Earth observation systems. (5-2)
11. Provide advanced aeronautical technologies to meet the challenges of next-generation systems in aviation, for civilian and scientific purposes, in our atmosphere and in the atmospheres of other worlds. (3-2)
12. Use NASA missions and other activities to inspire and motivate the nation's students and teachers, to engage and educate the public, and to advance the scientific and technological capabilities of the nation. (3-3) (4-3)
13. Develop a comprehensive national plan for utilization of nuclear systems for the advancement of space science and exploration.

Strategic Roadmaps

Roadmap	Tri - Chairs		
	Directorate	Center	External
1. Robotic and human lunar expeditions	Steidle/Readdy	Howell	T. Stafford
2. Sustained, long-term robotic and human exploration of Mars	Diaz	Elachi	T. Young
3. Sustained program of solar system exploration	Figueroa	Hubbard	J. Lunine
4. Advanced telescope searches for Earth-like planets and habitable environments	Asrar	Bleichman	A. Burrows
5. Develop an exploration transportation system	Steidle	Kennedy	C. Bolden
6. Complete assembly of the International Space Station and focus utilization	Uhran	Cabana	T. Betterton
7. Safely transition from Space Shuttle to new exploration-focused launch systems*	*Deferred**	*Deferred**	*Deferred**
8. Explore the origin, evolution, structure, and destiny of the Universe	Kinney	White	K. Flanagan
9. Determine how living Earth system is affected by internal dynamics, and understand implications for life	Figueroa	Evans	C. Kennel
10. Explore Sun-Earth system to understand effects on Earth and implications for human exploration	Diaz	Einaudi	T. Killeen
11. Transform air transportation and enable the next generation of atmospheric vehicles	Hertz	N/A	J. Jamieson
12. Educate students and public, and expand national technical skills and capabilities	Loston	Earls	F. Cordova
13. Comprehensive national plan for utilization of nuclear systems	Steidle	Scolese	J. Ahearne

= DoD Participation

* Leverages off Integrated Space Operations Summit, (ISOS) process until RTF

Why is NASA doing strategic roadmaps and how will we use them?

New NASA Advanced Planning Function

- **NASA has transformed the strategic planning process and created several new Agency-level planning and coordination functions**
- **Director for Advanced Planning**
  - Develops input, options, and assessments for **Strategic Planning Council**
    - **Overall Agency architecture** and requirements flow-down process
    - **Science/exploration/policy strategies** and capability roadmaps (with Directorates)
    - New initiatives and studies of strategic issues
- **Advanced Planning and Integration Office**
  - Provides staff support to above Director for Advanced Planning and Associate Deputy Administrator for Systems Integration
  - **Coordinates development of strategies, roadmaps**, and new initiatives, **working with Mission Directorates and external advisory groups**; manages development of the NASA Strategic Plan

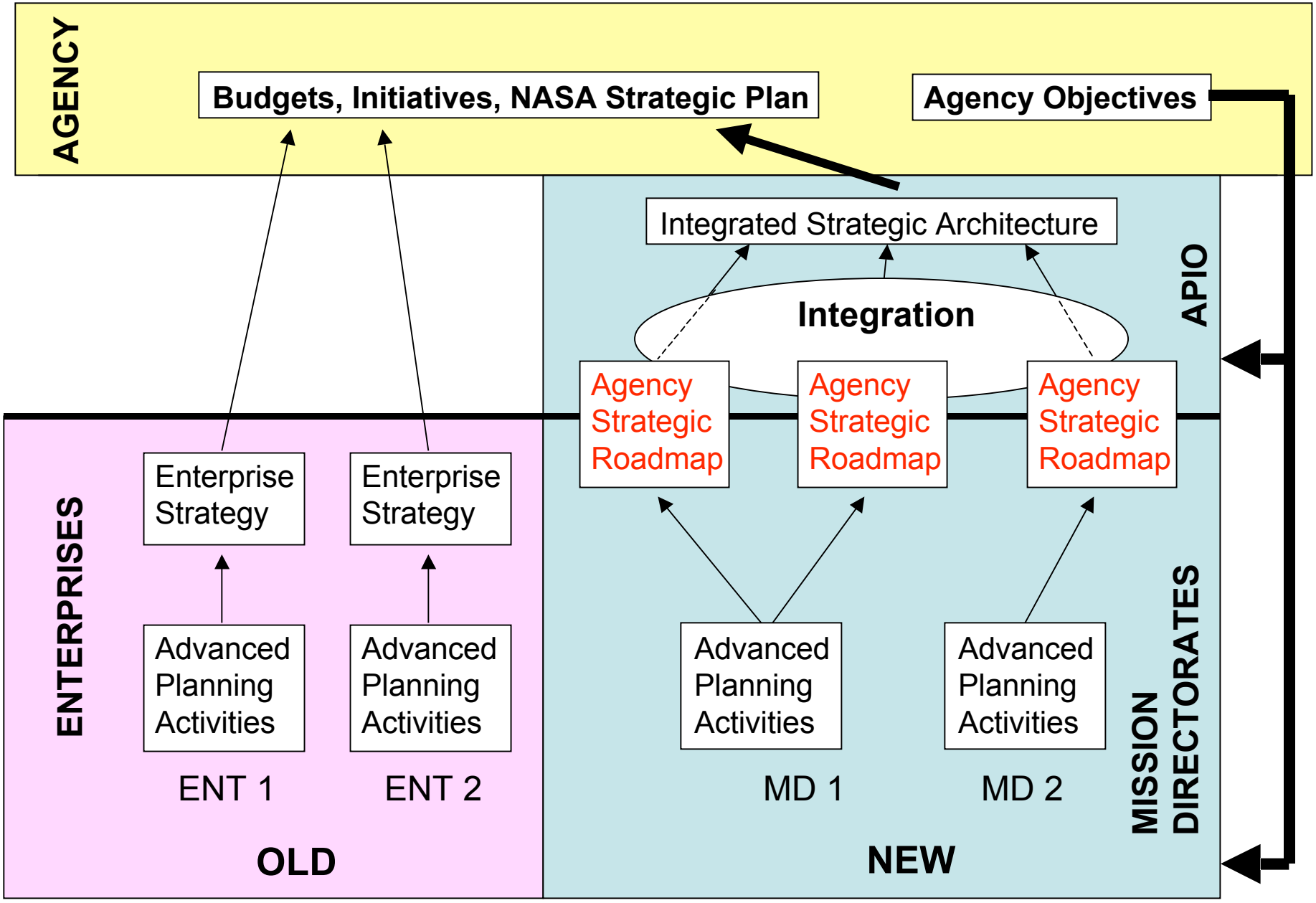
Purpose of Roadmapping

- Purpose of roadmapping is to support creation of the NASA

Integrated Strategic Architecture (ISA)

- Strategic and Capability Roadmaps are to be integrated into this single, self-consistent multi-decade plan for the Agency
- This integration takes into account projected constraints of
  - Budget
  - Technology
  - Programmatics (e.g., institutional and external capabilities)
  - Environmental factors
- The ISA is presented to, and ultimately owned by, the Strategic Planning Council
- The ISA will be the benchmark for Agency budget request and resource allocation decisions

Strategic Planning – Old vs. New



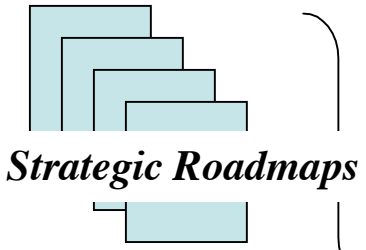
Integration Challenges

- **Achieving this goal will be tough**
  - Each roadmap is different, and there are 13 of them
  - The Capabilities Roadmaps are being developed in parallel with the Strategic Roadmaps
  - Many and varied relationships among the Strategic and Capability Roadmaps
  - Cross-talk between the Strategic Roadmaps, and between the Directorates on a given Roadmap
  - Overlap between some Strategic and Capabilities Roadmaps
  - The schedule is tight!
- **Structure and contents of the roadmaps are being planned to permit integration: *post hoc* won't work**

Integration Approach

- **Details of the process are still being invented**
- **Strategic Roadmap integration activities will run concurrently with roadmap development**
- **Two key activities**
  1) Near-term and on-going: identify, capture, and analyze inter-roadmap dependencies
  2) Episodic and terminal: analyze roadmaps; resolve dependencies in context of budget, technology, and other factors; establish framework of ISA
- **Implementation of (1)**
  - Key rep for each committee is APIO Coordinator
  - APIO Coords from closely related strategic roadmaps will meet between meetings
  - APIO coordinator will summarize identified issues at the end of every meeting and report on inter-meeting analysis results at the beginning of each meeting
- **Implementation of (2)**
  - Synthesis team will formed of experienced system engineers, technologists, and budget analysts (role of Capabilities Roadmap)
  - Current plan: will meet twice to formulate content of the ISA

Integration Process Flow



Strategic Roadmaps

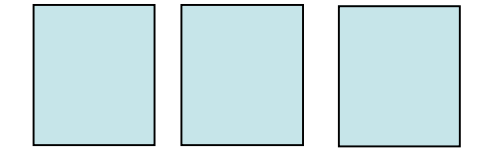
Capabilities and
Agency guidance:

- Policy
- Budget
- Priorities

Identify relationships, dependencies, sequences

Synthesize architectural options

Iterate with Roadmap Teams

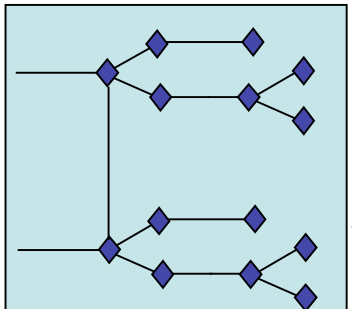


Steering Group Reviews
(Roadmap Co-chairs)

Assessment:

- Affordability
- Flexibility
- Achievements
- Etc.

Strategic Planning Council



Strategic Architecture

- Strategic Decisions
- New Initiatives
- Strategic Plan

What Should a Roadmap Contain?

Essential Roadmap Elements

- Broad science and exploration goals, priorities, recommended activities or investigations, and a summary of anticipated discoveries and achievements
- Suggested implementation approach and mission sets
- High-level milestones, options, and decision points
- Key dependencies on and relationships to other Strategic Roadmaps
- Identification of required capabilities, facilities, human capital, and infrastructure

Provisional Roadmap Outline

1. **Agency Objective Statement**
2. **Flow-down Objectives within a Stages and Pathways Framework**
3. **Recommended Investigations, Missions, R&D Programs, etc., Mapped to the Objectives/Stages/Pathways Framework**
4. **Summary of Key Program Milestones, Options, & Decision Points**

APPENDIXES

A. National Policy Framework and External Constituencies
B. Required Capabilities Mapped to Stages/Pathways Decision Points
    i. Technology
    ii. External Industrial and Academic Capacities
    iii. Agency Human Capital
    iv. Applicable Agency Infrastructure
    v. Unique Requirements
C. Unique Education and Outreach Opportunities
D. Critical Inter-Roadmap Dependencies
E. External Partnerships
    i. USG Agencies
    ii. International Partners
F. Bibliography of Key Agency Documents and NRC Documents

Appendix Example: Some Top Level Core Competency Questions

Human Capital

1. Are there workforce skills or competencies needed that are critical to execute this roadmap?

2. Are there any special Human Capital planning considerations that the team thinks should be highlighted?

Facilities (and other physical infrastructure)

3. Are there critical facilities or other physical infrastructure needed to execute this roadmap that the roadmapping team thinks should be highlighted?

NRC Review

NRC will review the individual roadmaps as they near completion

- Clear and comprehensive support to the 2005 Agency Objectives, including the objectives of the Vision for Space Exploration and the 2003 NASA Vision and Mission statements? Significant gaps?
- Intrinsic merit of the derived objectives and merit of proposed implementing programs in the context of relevant NRC or other external advisory reports?
- Resilience with respect to changing technological capabilities and budgets and agility to take advantage of unforeseen opportunities?
- Important crosscutting opportunities not identified or adequately developed?
- Clear initial priorities and decision rules for making prioritization decisions as implementation proceeds?
- Realism with respect to necessary resources, technologies, and facilities? Presentation of roles and relationships of NASA centers, other federal partners, academia, industry, and international participants?
- Treatment of timelines, relationships between program elements, and schedule realism?

Current plan: The NRC and/or the NASA Advisory Council will review the Integrated Space Architecture when completed

An Example of the
Strategic Roadmap Concept:

The Mars Pathways Model

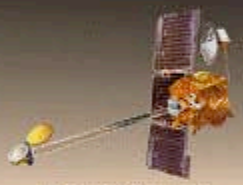
MEP—The Current Decade

Launch Year

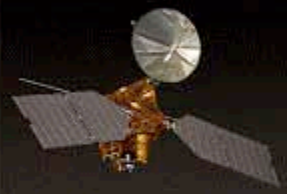
OPERATIONAL	2005	2007	2009	...Next Decade

Mars Global Surveyor

ESA
Mars Express



Mars Odyssey



Mars
Reconnaissance
Orbiter
(Italian SHARAD)

Mars Telesat

Explore the
Evolution of Mars

Search for
Evidence of Past Life

Science pathways
responsive to discovery

Search for Present Life

Competed Scout Mission

Mars
Exploration
Rovers

Phoenix

Mars Science
Laboratory

Explore
Hydrothermal
Habitats

Mars Potential Next-Decade Pathways

Pathway	Lines of Scientific Inquiry

Search for Evidence of Past Life	• Science from First Decade missions plus early next-decade missions confirms ancient Mars was wet and warm
	  • Locating and analyzing water-lain sedimentary rock is primary goal.
	  • Pathway includes search for evidence of past life.

Explore Hydrothermal Habitats	• Exploration in First Decade discovers hydrothermal deposits (active or fossil)
	  • Probability of hydrothermal regions being discovered is potentially high.
	  • Hydrothermal habitats are focus of second decade of Mars exploration.
	  • Potential for discovery of evidence of past and present life is greatly improved.

Search for Present Life	• Commits to search for present life at sites determined to be modern habitats by First Decade missions
	  • Search for life at active hydrothermal deposits or polar margins.
	  • Path would be taken only following a discovery that revolutionizes our understanding of the potential of Mars to harbor present life.
	  • MSR with mobility is included as the most reliable, validatible means of detecting life.

Explore Evolution of Mars	• Science of First Decade of Mars exploration does not find evidence of past or present liquid water environments
	  • Determine the loss mechanisms and sinks for water and CO_2 over time.
	  • Determine why the terrestrial planets evolved differently, much more so than we had thought.
	  • Determining whether the initial conditions on Venus, Earth and Mars were similar or very different.

…and Potential Pathway Mission Sequences

Pathway	2009	2011	2013	2016	2018	2020	Notes
Search for Evidence of Past Life	MSL to Moderate Latitude	Scout	MSR	Scout	Astrobiology Field Lab or Deep Drill	Scout	Missions to high-probability past habitat. Mission in '18 influenced by MSL results.
Explore Hydrothermal Habitats	MSL to Hydrothermal Deposit	Scout	Astrobiology Field Laboratory	Scout	Deep Drill	Scout	All core missions sent to active or extinct hydrothermal deposits.
Search for Present Life	MSL to High Latitude or Active Vent	Scout	Scout	MSR	Scout	Deep Drill	Missions to modern habitat. Path has highest risk.
Explore Evolution of Mars	MSL to Moderate Latitude	Scout	MSR	Aeronomy	Network	Scout	Path rests on proof that Mars was never wet.

2005 President's Budget Augmentation		Scout & Mars Testbed		Mars Testbed		Mars Testbed	

MTO → Replacement Telecom* →

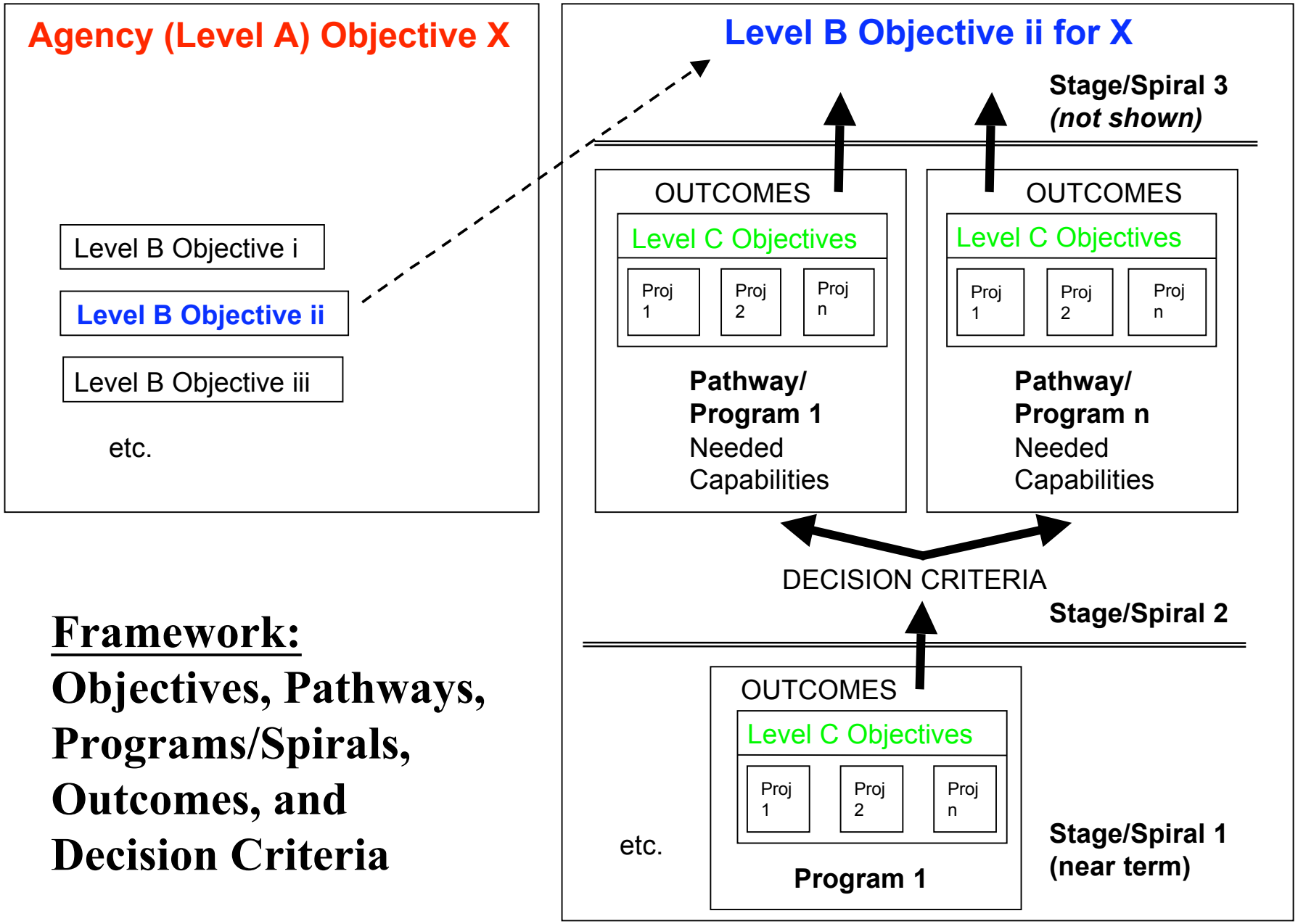
Note: The pathway followed will depend on knowledge and technologies developed this decade.

Schedule

Current Schedule

Key Milestone	Target Dates
SPC approval of planning	August 2004
FACA charters in place	December
Complete committee formation	December 2004/January 2005
Initial cttee meetings; integration begins	January/February
Mid-term status reviews	March
Drafts (PPT charts+notes) for internal review	April 15
First synthesis workshop	Late April
Roadmaps submitted for NRC review	**June 1**
Second synthesis workshop	Late June
NRC reviews complete	August 1
Integrated Strategic Architecture complete	October 1

BACKUP



Framework:
Objectives, Pathways, Programs/Spirals, Outcomes, and Decision Criteria

Organization: Integration Elements

Advanced Planning & Integration Office

Integration lead: Brant Sponberg

Integration lead: Paul Hertz

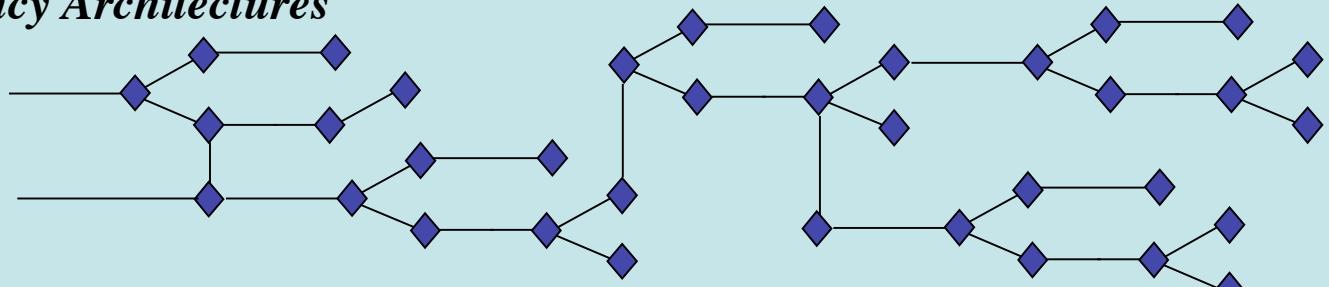
Extending Robotic and Human Presence

Scientific Achievements of Robotic and Human Exploration

- Aeronautics (for transportation)
- Space Station
- Exploration Transportation System
- Nuclear Systems
- Sun-Earth System
- Solar System Exploration
- Lunar Exploration
- Mars Science and Exploration

- Aeronautics (for science)
- Earth System Science
- Extrasolar Planets
- Universe - Origin and Destiny
- Sun-Earth System
- Solar System Exploration
- Lunar Exploration
- Mars Science and Exploration

Agency Architectures



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